Power Level and Time Influence of Microwave on Dog Treat Baking

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Abstract

As the demand for dog food increases, the pet industry utilizes ovens to produce more to satisfy the market, which causes more serious air pollution and other environmental problems. Microwave oven is a better cooking equipment to alternate the traditional oven. Microwave ovens require less time and energy to heat up the food. Using Microwaves to bake dog treats can reduce time, money, energy and pollution. In this project, the Peanut Butter Dog Treat recipe produced by Becky Hardin, would be baked in a microwave oven at different power levels at different times. The specific aim of the project is to find out the best baking time and power level set to ensure the water activity in the sample to be below .4 aw. For each power level, three sets of time were applied. In this study, power level 8 in 1 minute was found to be the best parameter setting for baking dog treats with the water activity below .4 aw. In addition, dog treats after baking at this parameter setting have less water activity difference between the inside and the outside. The hardness is 10808 force (g), which was in the acceptable range of 6283-11643 force(g).

Introduction:

In the United State, Pet ownership has increased significantly in recent years. Sixty-eight percent of households have at least one pet in 2014 (1). Pet owners are willing to pay more for pet food. Since the demand for pet food increases, the market for pet food has expanded, and the production also increases accordingly. In manufactories, dog dry food is processed in a tunnel oven which has 100-300 ft (5). It requires a lot of energy to finish the product. Using Oven also generates other particulate problems. For example, dry pet food production is creating 56-1.51 million tons of CO_2 equivalent emissions worldwide per year, which occupies 1.1-2.9% of global agricultural emissions (4). It becomes a large pollution issue gradually.

An oven needs to take a long time to heat up to a high temperature. This increases the cost of energy. Microwave oven is good cooking equipment to alternate traditional ovens. Microwave ovens require less energy to heat up the food, both saving time and electricity. The key point is that microwaves do not produce too much pollution, which can help save the environment.

In this project, the specific aim is to find out the best time and power level setting for baking an acceptable dog treat, so as to alternate the traditional oven, thus reducing the environmental issue.

Material and Methods

Dog treat is one of the important foods for pet owners to train their pets. It has been reported that there were 63.5 % of pet owners who would purchase treat food for their pets (2). Therefore, in this project, Peanut Butter Dog Treat was used as an example to explore the best processing parameter setting by microwave oven. Peanut Butter Dog Treat is a healthy dog treat, which contains peanut butter to provide flavor as well as healthy fats, vitamin A, and vitamin C (3). The recipe is created by Becky Hardin (3). The Dog treat dough was made of 320 g whole flour, 128 g water, 128 g peanut butter, an egg, and 30 g honey. After mixing all the ingredients into a dough, it had .9269 Aw. Then the dough was cut into small pieces. An EPW sample cup was used to shape the samples. Each sample was shaped in a cylinder with 4 cm in diameter, 6 mm thickness and was around 8.5g. After the samples were prepared, the microwave was heated within a cup of water for 30 s. This ensured the first sample wouldn't start at a low temperature, which could affect the doneness. Then the dough was heated on a plastic plate in Microwave oven (LG 24 Inch Wide 2.0 Cu. Ft. 1200 Watt Countertop Microwave with Smart

Inverter), from 1-10 power level, in specific times (Table 2). The baking time was based on the water activity in the sample, which is needed to be below .4 aw. After baking, the sample was cut to two pieces (inside and outside). The samples were measured in a water activity meter (AQUALAB 4TE water activity meter) for water activity, and Texture Analysis software (Exponent Connect) for hardness. Each set of time and power level were repeated three times.

There were three brands of dog treat used as reference samples in this project.

- Chewy Tricky Trainers Liver Flavor Dog Treats from Cloud Star
- Natural Grain Free Old Fashioned Peanut Butter Biscuit Recipe Dog Treats from Pet by Tasty
- Natural Bear Crunch Grain-Free Chicken, Pumpkin & Apple Dog Treats from Charlee Bear.

Measuring water activity and the hardness of these three products help to identify the target water activity that the result needs to meet. A water activity meter (AQUALAB 4TE water activity meter) and Texture Analysis software (Exponent Connect) were applied, and three times replicates were performed to find the average point of each product (Table 1).

Table 1: The Water activity and Hardness of dog treat from reference samples (Cloud Star, Pet by Tasty, Charlee Bear)

	Cloud Star	Pet by Tasty	Charlee Bear
Water Activity (aw)	.3971 SD=.0022	.3922 SD=.0037	.4204 SD=.0175
Hardness (Force (g))	8376 SD=2994.48	11643 SD=1670.31	6283 SD=775.13

In Table 1, water activity and hardness from three brands of dog treats (reference samples) are reported. In this project, water activity is the main concern because it can affect the bacteria growth. The data from the reference samples helped to identify the target water activity that the result needs to meet. The average water activity of all brands samples was 0.4 aw. This would be the target for water activity for the project sample needed to meet. For the hardness, it tells how hard the sample is. The hardness of three samples ranges from 6283-11643.

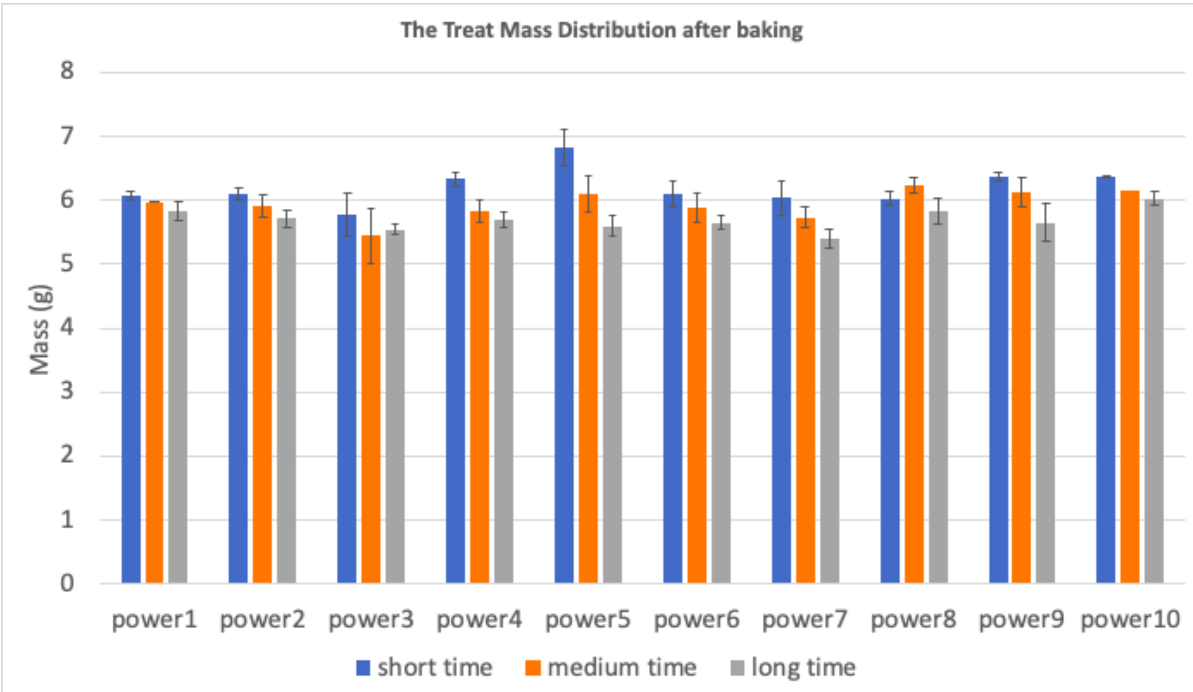
Table 2: The baking times (Short, Medium, Long) in each Power Level

Power Level	Short time (minute) (>=.4 aw)	Medium time (minute) (<=.4 aw)	Long time (minute) (<.4 aw)
1 (60w)	16	18	20
2 (120w)	5	7	9
3 (180w)	3	4	5
4 (240w)	2	3	4
5 (300w)	1	1.5	2
6 (360w)	1	1.25	1.5
7 (420w)	1	1.33	1.67
8 (480w)	.83	1	1.17
9 (540w)	0.67	.83	1
10 (600w)	.5	1.67	.83

In Table 2, there were three sets of baking times in each power level. Medium time was the baking time when the water activity of the sample was meeting and below .4 aw. Short time was the baking time when the water activity of the sample was close to .4 aw, but above .4aw. Long time the baking time when the water activity of the sample exceeded below .4 aw. The purpose of setting three levels of time was to see as the baking time increases, which is the rate of doneness in each power level.

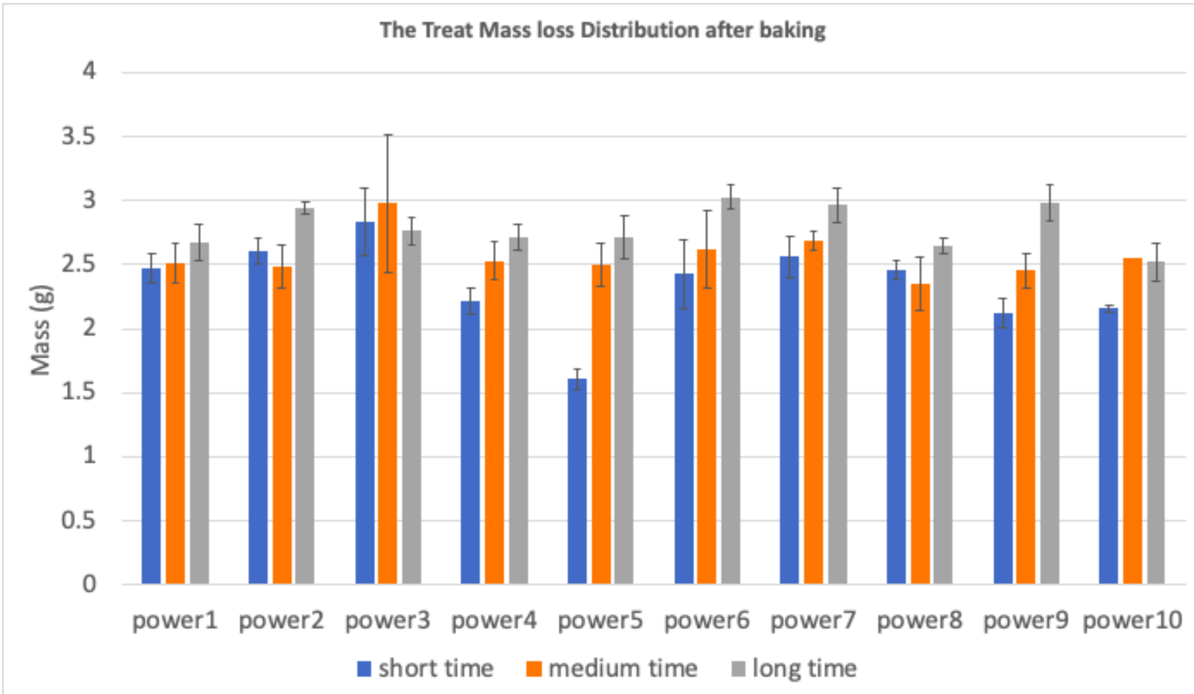
Results and Discussion

Figure 1: The Treat Mass Distribution after baking



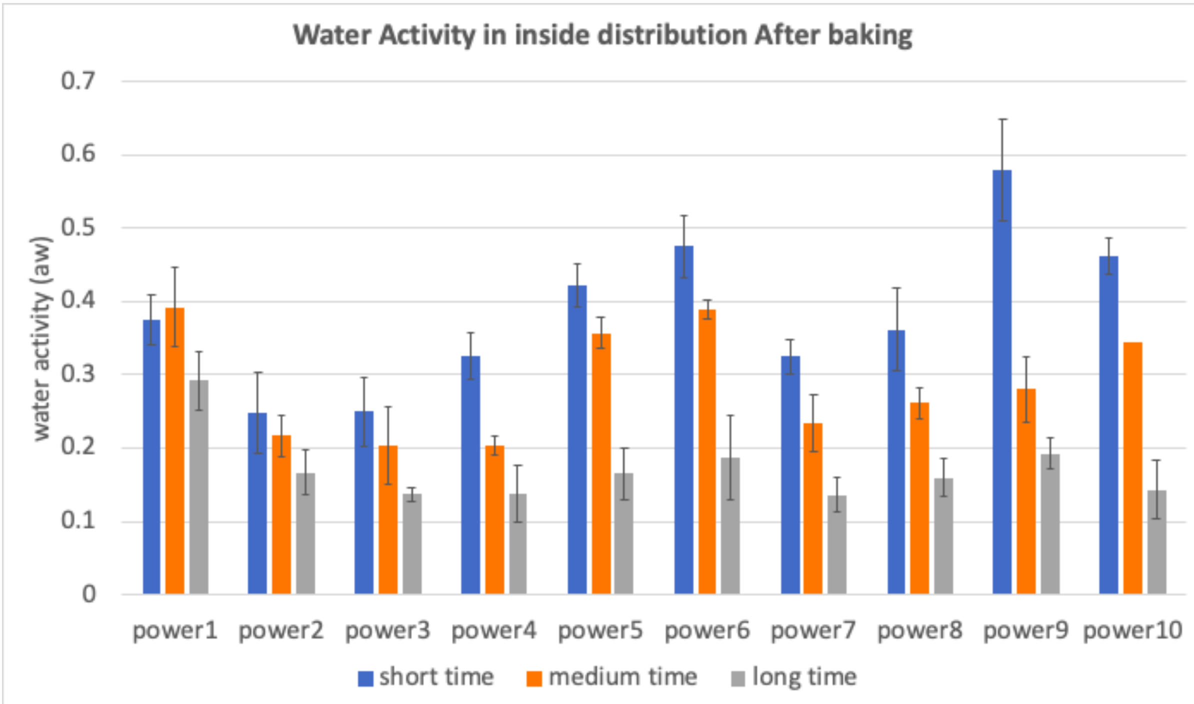
In figure 1, the data represent the mass of the samples after baking. Every sample is around 8.5g and .9269aw before baking. Power Level 1, 2, 4, 5, 6, 7, 9, 10, had the same pattern in mass changing trend. Their short time had the highest mass, and the long time had lower mass. In power level 3, The medium time has the lowest mass. In power level 8, The medium time has the highest mass. This could be caused when samples did not weigh properly in 8.5g before baking. This affects the mass of the baked sample. To solve this problem, each dough needs to weigh at least three times to ensure the mass is 8.5g in the future study.

Figure 2: The Treat Mass loss Distribution after baking



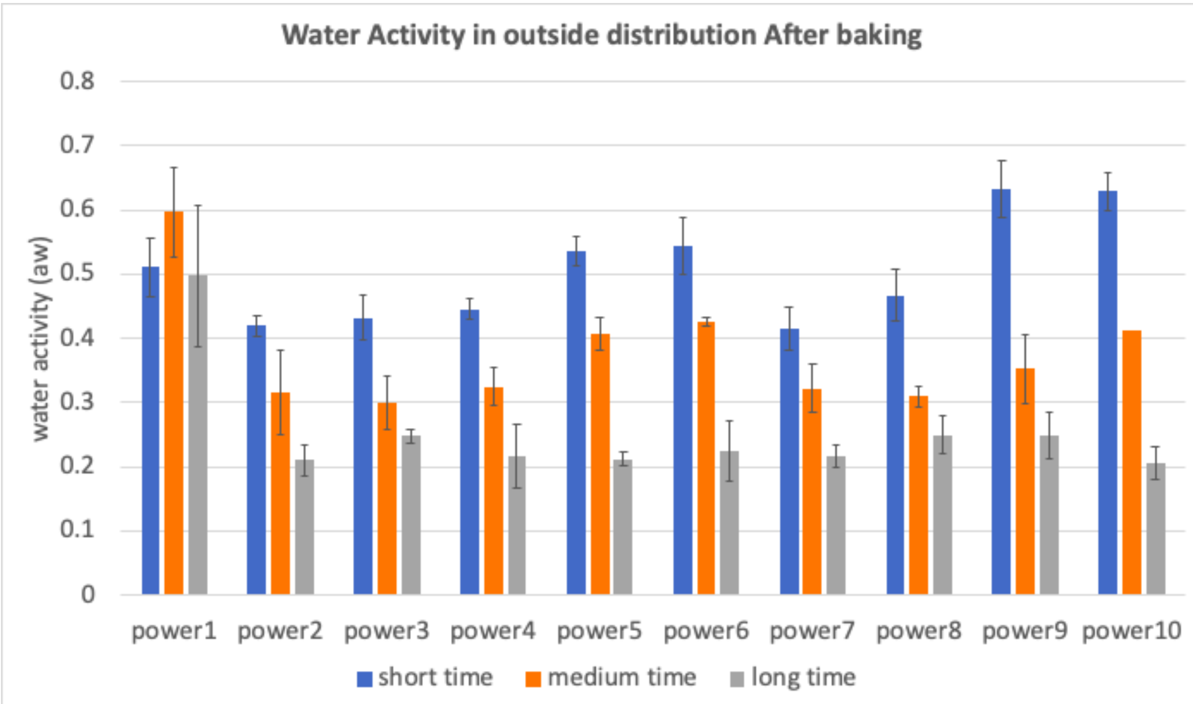
In figure 2, the data represent the loss mass in the samples after baking. The loss mass was the water evaporating during the microwave. The equation for loss mass is 8.5g minus the mass of the baked sample. In power level 1, 4, 5, 6, 7, 9, Those have the same result. Their short time had the losing less mass, and the long time had losing more mass. In power level 2, 3, 8, 10, the data was unexpectable. The medium time should not have the highest or lowest loss mass. This could be caused when the samples did not weigh properly. This affects the final mass of the baked sample. To solve this problem, each dough needs to weigh at least three times to get more accuracy data.

Figure 3: Water Activity in inside distribution After baking



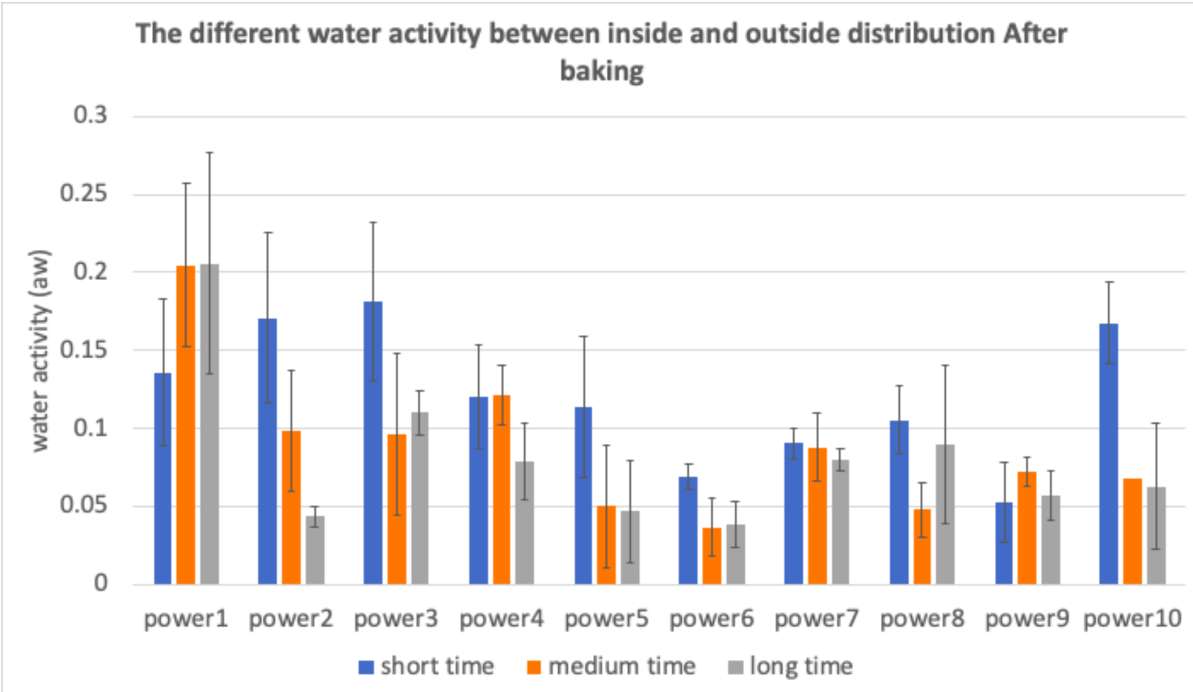
In figure 3, the data represent the water activity inside of the samples. Power level 2, 3, 4, 5, 6, 7, 8, 9, 10 had the same result, short time has more water activity, long time has less water activity. As the baking time increased, more water was evaporating. Also, As the power level increased, water was evaporating faster, this caused a large difference in water activity between time as the power level increased. In power level 1, the water activity in the medium was higher than in the short time. This could be caused when the inside piece did not cut properly, the piece may contain outside pieces. This could affect the data in water activity.

Figure 4: Water Activity in outside distribution After baking



In figure 4, the data represent the water activity of outside pieces. Power level 2, 3, 4, 5, 6, 7, 8, 9, 10 had the same result, short time has more water activity, long time has less water activity. As the baking time increased, more water was evaporating. Also, as the power level increased, water was evaporating faster, this caused a large difference in water activity between time as the power level increased. In power level 1, the water activity in the medium was higher than in the short time. This could be caused when the outside piece did not cut out properly, the piece may contain inside pieces. This could affect the data in water activity.

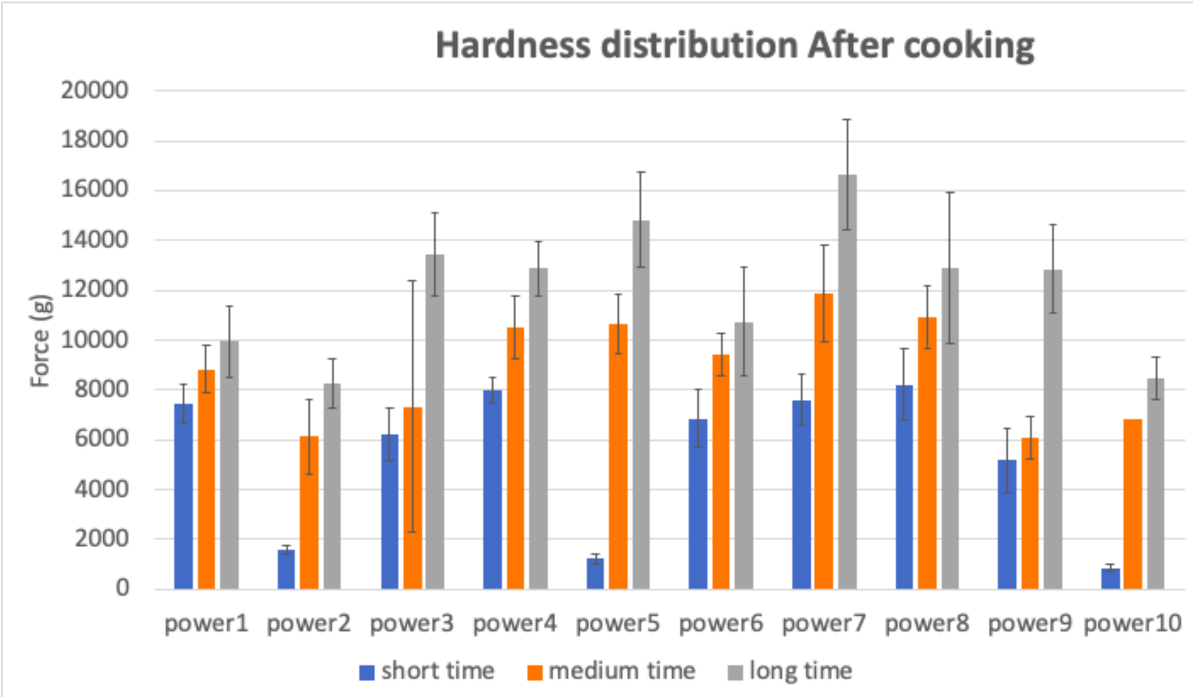
Figure 5: The different water activity between inside and outside distribution After baking



In Figure 5, the data represent the difference in water activity between inside and outside pieces. To find the difference, the equation is the mass of water activity outside minus that of the inside. The water activities in the outside were higher than the water activities in the inside. This means the heat starts from the center of the sample and then transfers out. The water was moving out from the inside during processing. This made less water activity inside, high water activity outside. As we can see, when the power level increases, the difference of water activity between outside and inside pieces would decrease. This means during a lower power level, the water was moving out of the sample, but the heat was not enough to let the water evaporate, the water was locked in the outside pieces. So, the outside piece has much more water than the inside pieces. For higher power levels, higher temperature lets the water evaporate faster. Therefore, shorter time with lower power level should have more difference, since a shorter time could only evaporate less amount of water. In power levels 1, 3, 8, 9, the data was unexpectable. This could be caused when baking a sample, the microwave was too warm to start the next sample. This could affect the evaporation rate during baking. To solve this problem, the temperature needs to be the same before baking the sample.

Overall, power level 8 in 1 minutes (medium time) would be the best choice. The water activity in outside and inside pieces were below .4 aw. It has less different water activity between inside and outside.

Figure 6: Hardness distribution After baking



In figure 6, the datas represent the hardness of each sample. In all power levels, samples in long time had the highest hardness, samples in short time had lowest hardness. In power level 2, 5, 10, the sample in short had very low hardness. This would happen because the time is too short for the sample to bake, outside was still raw. This causes it to be softer outside.

Compared with figure 4, power level 9 in a short time should have the lowest hardness based on the high water activity outside. This could be caused when the samples may sit for a long time, the texture becomes dry and hard. This affects the result while collecting data.

Conclusion

The power level and time affects the rate of evaporation. The higher power level, the more evaporation. The lower the power level, the less evaporation after baking. For the mass loss during baking. The shorter baking time had the highest mass, and the longer baking time had a lower mass after baking. For the difference between inside and outside pieces (water activity), as the power level increases, the difference would decrease, as the power level decreases, the difference would increase. For Hardness, samples processed within longer time had the highest hardness, samples in shorter time had the lowest hardness.

To sum pu, Power level 8 in 1 minute would be the best choice for baking dog treat. The water activity is below .4 aw. It has less different water activity between inside and outside. The hardness is 10909 forces (g), which was in the range of 6283-11643 and acceptable.

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